環天衛星科技股份有限公司

# PRODUCT USER MANUAL

# GPS RECEIVER ENGINE BOARD

# EM-411

**GlobalSat Technology Corporation**
**台北縣中和市建一路 186 號 16 樓(遠東世紀廣場)**
**16, No.186,Chien 1 Road, 235Chung Ho City,Taipei Hsien, Taiwan ,R.O.C.**
**Tel: 886-2-8226-3799(Rep.)** **Fax: 886-2-8226-3899**
**Web: www.globalsat.com.tw** **E-mail:service@globalsat.com.tw**

**Features:**

SiRF starⅢ high performance GPS Chip Set
Very high sensitivity (Tracking Sensitivity: -159 dBm)
Extremely fast TTFF (Time To First Fix) at low signal level
Support NMEA 0183 data protocol
Built-in SuperCap to reserve system data for rapid satellite acquisition
Built-in patch antenna
LED indicator for GPS fix or not fix

| | |
|---|---|
| LEDOFF: | Receiver switch off |
| LED ON: | No fixed, Signal searching |
| LED Flashing: | Position Fixed |

**Specification:**

**General**

| | |
|---|---|
| Chipset | SiRF StarⅢ |
| Frequency | L1, 1575.42 MHz |
| C/A code | 1.023 MHz chip rate |
| Channels | 20 channel all-in-view tracking |
| Sensitivity | -159 dBm |

**Accuracy**

| | |
|---|---|
| Position | 10 meters, 2D RMS |
| | 5 meters, 2D RMS, WAAS enabled |
| Velocity | 0.1 m/s |
| Time | 1us synchronized to GPS time |

**Datum**

| | |
|---|---|
| Default | WGS-84 |

**Acquisition Time**

| | |
|---|---|
| Reacquisition | 0.1 sec., average |
| Hot start | 1 sec., average |
| Warm start | 38 sec., average |
| Cold start | 42 sec., average |

**Dynamic Conditions**

| | |
|---|---|
| Altitude | 18,000 meters (60,000 feet) max |
| Velocity | 515 meters /second (1000 knots) max |
| Acceleration | Less than 4g |
| Jerk | 20m/sec **3 |

**Power**

| | |
|---|---|
| Main power input | 4.5V ~ 6.5V DC input |
| Power consumption | 60mA |

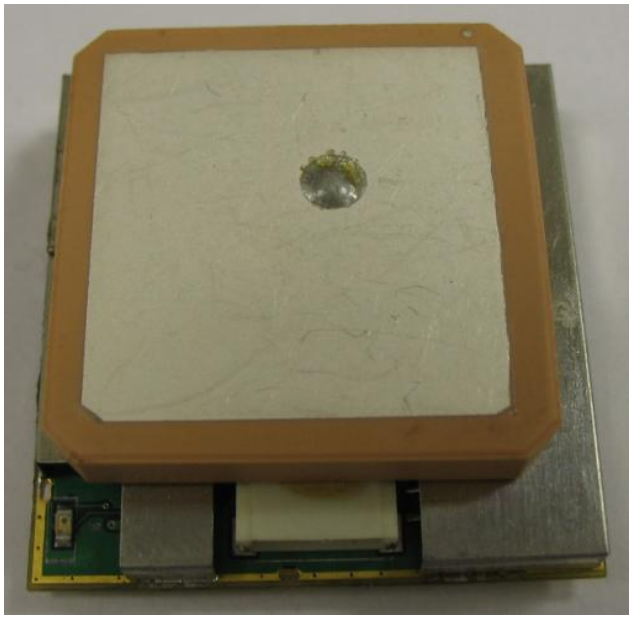
**Protocol**

| | |
|---|---|
| Electrical level | TTL level, Output voltage level: 0V ~ 2.85V<br>RS-232 level |
| Baud rate | 4,800 bps |
| Output message | NMEA 0183 GGA, GSA, GSV, RMC, VTG, GLL |

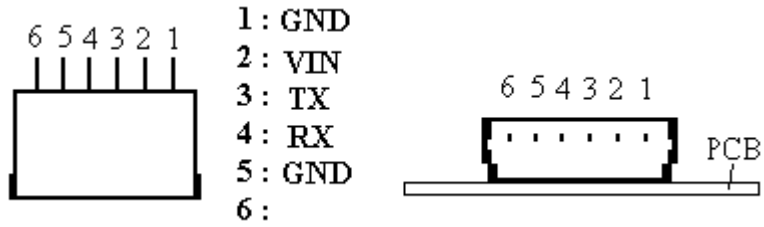
**Physical Characteristics**

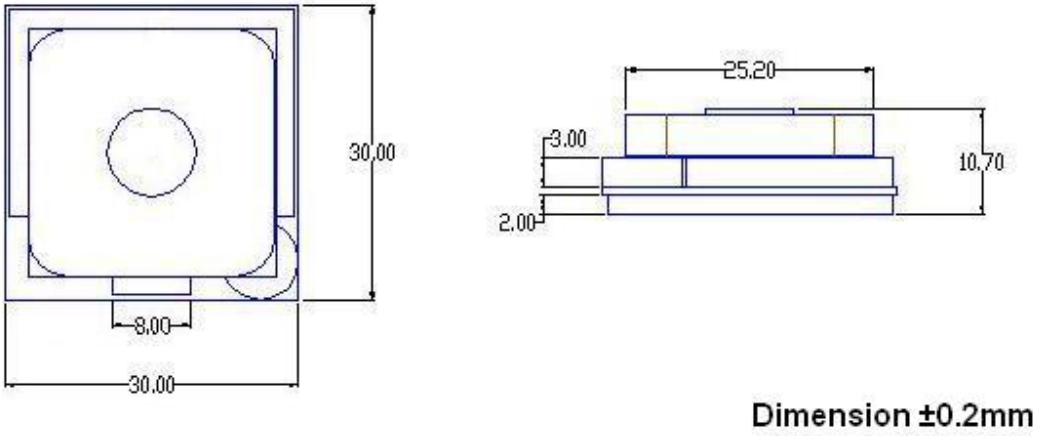
| | |
|---|---|
| Dimension | 30mm*30mm*10.5mm ±0.2mm |

**Operating temperature** -40℃ to +85℃



**Pin Assignment**




**Pin description**

*** VIN (DC power input):**

This is the main DC supply for a 4.5V ~6.5 DC input power.

*** TX:**

This is the main transmits channel for outputting navigation and measurement data to user's navigation software or user written software.

*** RX:**

This is the main receive channel for receiving software commands to the engine board from SiRFdemo software or from user written software.

*** GND:**

GND provides the ground for the engine board. Connect all grounds.

# SOFTWARE COMMAND

## NMEA Output Command

### GGA-Global Positioning System Fixed Data

Table B-2 contains the values for the following example:

$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

Table B-2 GGA Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGGA | | GGA protocol header |
| UTC Time | 161229.487 | | hhmmss.sss |
| Latitude | 3723.2475 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12158.3416 | | dddmm.mmmm |
| E/W Indicator | W | | E=east or W=west |
| Position Fix Indicator | 1 | | See Table B-3 |
| Satellites Used | 07 | | Range 0 to 12 |
| HDOP | 1.0 | | Horizontal Dilution of Precision |
| MSL Altitude[1] | 9.0 | meters | |
| Units | M | meters | |
| Geoid Separation[1] | | meters | |
| Units | M | meters | |
| Age of Diff. Corr. | | second | Null fields when DGPS is not used |
| Diff. Ref. Station ID | 0000 | | |
| Checksum | *18 | | |
| <CR><LF> | | | End of message termination |

SiRF Technology Inc. does not support geoid corrections. Values are WGS84 ellipsoid heights.

Table B-3 Position Fix Indicator

| Value | Description |
|---|---|
| 0 | Fix not available or invalid |
| 1 | GPS SPS Mode, fix valid |
| 2 | Differential GPS, SPS Mode , fix valid |
| 3 | GPS PPS Mode, fix valid |

## GLL-Geographic Position-Latitude/Longitude

Table B-4 contains the values for the following example:

$GPGLL,3723.2475,N,12158.3416,W,161229.487,A*2C

Table B-4 GLL Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGLL | | GLL protocol header |
| Latitude | 3723.2475 | | ddmm.mmmm |
| N/S Indicator | n | | N=north or S=south |
| Longitude | 12158.3416 | | dddmm.mmmm |
| E/W Indicator | W | | E=east or W=west |
| UTC Position | 161229.487 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Checksum | *2C | | |
| <CR><LF> | | | End of message termination |

## GSA-GNSS DOP and Active Satellites

Table B-5 contains the values for the following example:

$GPGSA,A,3,07,02,26,27,09,04,15,,,,,1.8,1.0,1.5*33

Table B-5 GSA Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPGSA | | GSA protocol header |
| Mode1 | A | | See Table B-6 |
| Mode2 | 3 | | See Table B-7 |
| Satellite Used[1] | 07 | | Sv on Channel 1 |
| Satellite Used[1] | 02 | | Sv on Channel 2 |
| ….. | | | |
| Satellite Used[1] | | | Sv on Channel 12 |
| PDOP | 1.8 | | Position dilution of Precision |
| HDOP | 1.0 | | Horizontal dilution of Precision |
| VDOP | 1.5 | | Vertical dilution of Precision |
| Checksum | *33 | | |
| <CR><LF> | | | End of message termination |

1. Satellite used in solution.

Table B-6 Mode1

| Value | Description |
|---|---|
| M | Manual-forced to operate in 2D or 3D mode |
| A | 2Dautomatic-allowed to automatically switch 2D/3D |

Table B-7 Mode 2

| Value | Description |
|---|---|
| 1 | Fix Not Available |
| 2 | 2D |
| 3 | 3D |

## GSV-GNSS Satellites in View

Table B-8 contains the values for the following example:

$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42*71

$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41

Table B-8 GSV Data Format

| Name | Example | | Description |
|---|---|---|---|
| Message ID | $GPGSV | | GSV protocol header |
| Number of Messages[1] | 2 | | Range 1 to 3 |
| Message Number[1] | 1 | | Range 1 to 3 |
| Satellites in View | 07 | | |
| Satellite ID | 07 | | Channel 1(Range 1 to 32) |
| Elevation | 79 | degrees | Channel 1(Maximum90) |
| Azimuth | 048 | degrees | Channel 1(True, Range 0 to 359) |
| SNR(C/No) | 42 | dBHz | Range 0 to 99,null when not tracking |
| ……. | | | ……. |
| Satellite ID | 27 | | Channel 4 (Range 1 to 32) |
| Elevation | 27 | Degrees | Channel 4(Maximum90) |
| Azimuth | 138 | Degrees | Channel 4(True, Range 0 to 359) |
| SNR(C/No) | 42 | dBHz | Range 0 to 99,null when not tracking |
| Checksum | *71 | | |
| <CR><LF> | | | End of message termination |

Depending on the number of satellites tracked multiple messages of GSV data may be required.

## RMC-Recommended Minimum Specific GNSS Data

Table B-10 contains the values for the following example:

$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598,,*10

Table B-10 RMC Data Format

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPRMC | | RMC protocol header |
| UTC Time | 161229.487 | | hhmmss.sss |
| Status | A | | A=data valid or V=data not valid |
| Latitude | 3723.2475 | | ddmm.mmmm |
| N/S Indicator | N | | N=north or S=south |
| Longitude | 12158.3416 | | dddmm.mmmm |
| E/W Indicator | W | | E=east or W=west |
| Speed Over Ground | 0.13 | knots | |
| Course Over Ground | 309.62 | degrees | True |
| Date | 120598 | | ddmmyy |
| Magnetic Variation[2] | | degrees | E=east or W=west |
| Checksum | *10 | | |
| <CR><LF> | | | End of message termination |

SiRF Technology Inc. does not support magnetic declination. All “course over ground” data are geodetic WGS48 directions.

VTG-Course Over Ground and Ground Speed

$GPVTG,309.62,T,,M,0.13,N,0.2,K*6E

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $GPVTG | | VTG protocol header |
| Course | 309.62 | degrees | Measured heading |
| Reference | T | | True |
| Course | | degrees | Measured heading |
| Reference | M | | Magnetic |
| Speed | 0.13 | knots | Measured horizontal speed |
| Units | N | | Knots |
| Speed | 0.2 | Km/hr | Measured horizontal speed |
| Units | K | | Kilometers per hour |
| Checksum | *6E | | |
| <CR><LF> | | | End of message termination |

**NMEA Input Command**

## **A)**. Set Serial Port ID:100 Set PORTA parameters and protocol

This command message is used to set the protocol(SiRF Binary, NMEA, or USER1) and/or the communication parameters(baud, data bits, stop bits, parity). Generally,this command would be used to switch the module back to SiRF Binary protocol mode where a more extensive command message set is available. For example,to change navigation parameters. When a valid message is received,the parameters will be stored in battery backed SRAM and then the receiver will restart using the saved parameters.

Format:

$PSRF100,<protocol>,<baud>,<DataBits>,<StopBits>,<Parity>*CKSUM
<CR><LF>

| | |
|---|---|
| <protocol> | 0=SiRF Binary, 1=NMEA, 4=USER1 |
| <baud> | 1200, 2400, 4800, 9600, 19200, 38400 |
| <DataBits> | 8,7. Note that SiRF protocol is only valid f8 Data bits |
| <StopBits> | 0,1 |
| <Parity> | 0=None, 1=Odd, 2=Even |

Example 1: Switch to SiRF Binary protocol at 9600,8,N,1

$PSRF100,0,9600,8,1,0*0C<CR><LF>

Example 2: Switch to User1 protocol at 38400,8,N,1

$PSRF100,4,38400,8,1,0*38<CR><LF>

**Checksum Field: The absolute value calculated by exclusive-OR the 8 data bits of each character in the Sentence,between, but excluding “$” and “*”. The hexadecimal value of the most significant and least significant 4 bits of the result are convertted to two ASCII characters (0-9,A-F) for transmission. The most significant character is transmitted first.

**<CR><LF> : Hex 0D 0A

## B). Navigation lnitialization　ID：101　Parameters required for start

This command is used to initialize the module for a warm start, by providing current position （in X, Y, Z coordinates）,clock offset, and time.　This enables the receiver to search for the correct satellite signals at the correct signal parameters.　Correct initialization parameters will enable the receiver to acquire signals more quickly, and thus, produce a faster navigational solution.

When a valid Navigation Initialization command is received, the receiver will restart using the input parameters as a basis for satellite selection and acquisition.

**Format：**

$PSRF101,<X>,<Y>,<Z>,<ClkOffset>,<TimeOfWeek>,<WeekNo>,<chnlCount>,<ResetCfg>

*CKSUM<CR><LF>

| | |
|---|---|
| <X> | X coordinate position<br>INT32 |
| <Y> | Y coordinate position<br>INT32 |
| <Z> | Z coordinate position<br>INT32 |
| <ClkOffset> | Clock offset of the receiver in Hz, Use 0 for last saved value if available.　If this is unavailable, a default value of 75000 for GSP1, 95000 for GSP 1/LX will be used.<br>INT32 |
| <TimeOf Week> | GPS Time Of Week<br>UINT32 |
| <WeekNo> | GPS Week Number<br>UINT16<br>（ Week No and Time Of Week calculation from UTC time） |
| <chnlCount> | Number of channels to use.1-12. If your CPU throughput is not high enough, you |

| | |
|---|---|
| | could decrease needed throughput by reducing the number of active channels<br>UBYTE |
| <ResetCfg> | bit mask<br>0×01=Data Valid warm/hotstarts=1<br>0×02=clear ephemeris warm start=1<br>0×04=clear memory. Cold start=1<br>UBYTE |

Example: Start using known position and time.

$ PSRF101,-2686700,-4304200,3851624,96000,497260,921,12,3*7F

**C). Set DGPS Port ID:102 Set PORT B parameters for DGPS input**

This command is used to control Serial Port B that is an input only serial port used to receive
RTCM differential corrections.
Differential receivers may output corrections using different communication parameters.
The default communication parameters for PORT B are 9600 Baud, 8data bits, 0 stop bits, and no parity.
If a DGPS receiver is used which has different communication parameters, use this command to allow the receiver to correctly decode the data. When a valid message is received, the parameters will be stored in battery backed SRAM and then the receiver will restart using the saved parameters.
Format:

$ PSRF102,<Baud>,<DataBits>,<StopBits>,<Parity>*CKSUM<CR><LF>

| | |
|---|---|
| <baud> | 1200,2400,4800,9600,19200,38400 |
| <DataBits> | 8 |
| <StopBits> | 0,1 |
| <Parity> | 0=None,Odd=1,Even=2 |

Example: Set DGPS Port to be 9600,8,N,1

$ PSRF102,9600,8,1.0*12

**D). Query/Rate Control ID:103 Query standard NMEA message and/or set output rate**

This command is used to control the output of standard NMEA message GGA, GLL, GSA, GSV RMC, VTG. Using this command message, standard NMEA message may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery backed memory for each entry when the message is accepted.

Format:

$ PSRF103,<msg>,<mode>,<rate>,<cksumEnable>*CKSUM<CR><LF>

<msg>

0=GGA,1=GLL,2=GSA,3=GSV,4=RMC,5=VTG

| | |
|---|---|
| <mode> | 0=SetRate,1=Query |
| <rate> | Output every <rate>seconds, off=0,max=255 |
| <cksumEnable> | 0=disable Checksum,1=Enable checksum for specified message |

Example 1: Query the GGA message with checksum enabled

$ PSRF103,00,01,00,01*25

Example 2: Enable VTG message for a 1Hz constant output with checksum enabled

$ PSRF103,05,00,01,01*20

Example 3: Disable VTG message

$ PSRF103,05,00,00,01*21

**E). LLA Navigation lnitialization ID:104 Parameters required to start using Lat/Lon/Alt**

This command is used to initialize the module for a warm start, by providing current position (in Latitude, Longitude, Altitude coordinates), clock offset, and time. This enables the receiver to search for the correct satellite signals at the correct signal parameters. Correct initialization parameters will enable the receiver to acquire signals more quickly, and thus, will produce a faster navigational soution.

When a valid LLANavigationInitialization command is received,the receiver will restart using the input parameters as a basis for satellite selection and acquisition.

Format:

$ PSRF104,<Lat>,<Lon>,<Alt>,<ClkOffset>,<TimeOfWeek>,<WeekNo>,
<ChannelCount>, <ResetCfg>*CKSUM<CR><LF>

| | |
|---|---|
| <Lat> | Latitude position, assumed positive north of equator and negative south of equator float, possibly signed |
| <Lon> | Longitude position, it is assumed positive east of Greenwich and negative west of Greenwich Float, possibly signed |
| <Alt> | Altitude position float, possibly signed |
| <ClkOffset> | Clock Offset of the receiver in Hz, use 0 for last saved value if available. If this is unavailable, a default value of 75000 for GSP1, 95000 for GSP1/LX will be used. INT32 |
| <TimeOfWeek> | GPS Time Of Week UINT32 |
| <WeekNo> | GPS Week Number UINT16 |
| <ChannelCount> | Number of channels to use. 1-12 UBYTE |

| | | |
|---|---|---|
| <ResetCfg> | bit mask | 0×01=Data Valid warm/hot starts=1<br>0×02=clear ephemeris warm start=1<br>0×04=clear memory. Cold start=1<br>UBYTE |

Example: Start using known position and time.
$ PSRF104,37.3875111,-121.97232,0,96000,237759,922,12,3*37

**F). Development Data On/Off ID:105 Switch Development Data Messages On/Off**

Use this command to enable development debug information if you are having trouble getting commands accepted. Invalid commands will generate debug information that should enable the user to determine the source of the command rejection. Common reasons for input command rejection are invalid checksum or parameter out of specified range. This setting is not preserved across a module reset.

Format: $ PSRF105,<debug>*CKSUM<CR><LF>

| | |
|---|---|
| <debug> | 0=Off,1=On |

Example: Debug On $ PSRF105,1*3E
Example: Debug Off $ PSRF105,0*3F

**G). Select Datum ID:106 Selection of datum to be used for coordinate Transformations**

GPS receivers perform initial position and velocity calculations using an earth-centered earth-fixed (ECEF) coordinate system. Results may be converted to an earth model (geoid) defined by the selected datum. The default datum is WGS 84 (World Geodetic System 1984) which provides a worldwide common grid system that may be translated into local coordinate systems or map datums. (Local map datums are a best fit to the local shape of the earth and not valid worldwide.)

Examples:
Datum select TOKYO_MEAN
$PSRF106,178*32

| Name | Example | Units | Description |
|---|---|---|---|
| Message ID | $PSRF106 | | PSRF106 protocol header |
| Datum | 178 | | 21=WGS84<br>178=TOKYO_MEAN<br>179=TOKYO_JAPAN<br>180=TOKYO_KOREA<br>181=TOKYO_OKINAWA |
| Checksum | *32 | | |
| <CR> <LF> | | | End of message termination |